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EFFECT OF FEEDING CABBAGE AND POTATOES ON FLAVOR AND ODOR OF MILK

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The importance of succulent feeds in the ration of dairy cows is such that many crops not grown primarily for this purpose may enter into the ration. Cabbage and potatoes, though not grown for dairy feeds, are often fed to dairy cows as a means of supplying succulence and disposing economically of unmarketable products.

Like other succulent feeds,[1] cabbage and potatoes may have a tendency to impart undesirable flavors and odors to the milk. In order to determine whether such flavors and odors are imparted to the milk, feeding experiments were conducted by the Bureau of Dairying at its experiment farm at Beltsville, Md.[2] The specific objects of the investigation were: (1) To determine whether feeding cabbage or potatoes affects the flavor and odor of milk; and (2) to determine how they may be fed and the milk handled so as to minimize such effect, if objectionable, on the quality of the product.

[1] The effects of silage, green alfalfa, green corn, and turnips have been studied and reported in United States Department of Agriculture Bulletins, No. 1097, "The Effect of Silage on the Flavor and Odor of Milk;" No. 1190, "Effect of Feeding Green Alfalfa and Green Corn on the Flavor and Odor of Milk;" and No. 1208, "Effect of Feeding Turnips on the Flavor and Odor of Milk."

[2] The author acknowledges the assistance of T. E. Woodward, in charge of the dairy experiment farm, Beltsville, Md., and James L. Gordon, herdsman, who supervised the experimental work at the farm.

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EXPERIMENTAL FEEDING OF CABBAGE

PROCEDURE

THE COWS

The investigation was conducted with 6 Holstein and 10 Jersey cows. The cows selected were giving milk relatively free from abnormal flavors and odors when fed a basic hay-and-grain ration. They were representative of their respective breeds, the average weight of the Jerseys being 918 pounds, and of the Holsteins 1,145 pounds.

The stage of lactation varied from fresh cows to those nearing the end of their lactation period. The average daily milk production of the Jersey cows was 11.4 pounds, the highest individual daily average being 37.1 pounds, the lowest 3.6 pounds. The Holstein cows gave an average daily milk production of 32.8 pounds, the highest individual daily average being 50.5 pounds, the lowest 12.6 pounds. The average daily milk production of all cows was 20.2 pounds.

FEEDS

The cabbage fed was of good quality, free from decay. The heads were not solid on account of late planting. The only preparation for feeding was to chop the cabbage with a hoe. In addition the cows received, in proportion to the amount of milk produced, varying quantities of the following grain mixture: Hominy feed, bran, and oats, 100 pounds each; cottonseed meal and linseed meal, 50 pounds each. The ration was completed by feeding the cows all the alfalfa hay they would consume readily. This varied considerably, ranging from 4 pounds to 22 pounds, depending on the quantity of cabbage the cows were consuming.

METHOD OF FEEDING

The cows were divided into groups of four each. One group received only the basic hay and grain ration and were known as checks. The other three groups received, respectively, in addition to the hay and grain ration the following quantities of cabbage:

15 pounds one hour before milking.
30 pounds one hour before milking.
30 pounds immediately after milking.

The cows were fed these rations for four consecutive days; then for one day no cabbage was fed. The cows in the various groups were then interchanged in order to equalize any abnormal results in the milk of an individual animal, and the feeding of cabbage was resumed. The cows at times failed to consume all the cabbage fed.

MILK SAMPLES

Samples were taken from the milk of each cow at the time of milking, given a key number, and cooled but not aerated. The samples were judged for flavor and odor by experienced judges, who had no knowledge of the key. An "opinion," as this term is used in the following pages, denotes the decision of a judge in regard to one sample.

In judging the samples, all flavors and odors which the judges believed to be due to feed were designated as "abnormal," and the varying degrees in which they were found to be abnormal were classified as "very slightly off," "slightly off," and "off." When no feed flavors or odors were perceptible, the sample was rated "normal." It is doubtful whether the flavors and odors rated as "very slightly off" would be noticed by persons other than those accustomed to judging milk and cream, and the average consumer might have no serious objection to those samples rated by the judge as "slightly off."

CHECK FEEDING

The check samples were taken from the milk of the check cows, which were fed only the basic hay and grain ration. Some abnormal flavors and odors were noted in these samples but were mostly very slight, and were undoubtedly instances of the slight abnormal flavors and odors frequently encountered in milk from individual cows.

Out of a total of 324 opinions on 64 check samples, 94.2 per cent of the opinions on flavor and 93.8 per cent of those on odor showed a normal condition. The greater part of the abnormal flavors and odors, 4.6 per cent of the opinions on both flavor and odor, were rated as "very slightly off." Of the opinions on flavor 1.2 per cent and of the opinions on odor 1.6 per cent were rated as "slightly off." There were no opinions rating the samples "off" in either flavor or odor. (See Table 1 and fig. 1.)

TABLE 1.—*Opinions on flavor and odor of 64 samples of milk from cows fed basic rations of hay and grain (check cows)*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	305	94.2	304	93.8
Very slightly off	15	4.6	15	4.6
Slightly off	4	1.2	5	1.6
Off	0	0	0	0
Total	324	100.0	324	100.0

FEEDING AN AVERAGE OF 14.3 POUNDS ONE HOUR BEFORE MILKING

When the cows consumed an average of 14.3 pounds of cabbage (out of 15 pounds fed) one hour before milking, the flavor and odor of the milk were affected. A total of 271 opinions on 52 samples of milk produced by these cows showed that 34 per cent of the opinions on flavor and 30.3 per cent of those on odor rated the milk normal. Of the opinions designating abnormal flavors, 28 per cent rated the samples as very slightly off, 22.9 per cent as slightly off, and 15.1 per cent as off.

The abnormal odors did not vary greatly from the abnormal flavors, 31.7 per cent, 26.2 per cent, and 11.8 per cent rating the odor very slightly off, slightly off, and off, respectively. (See Table 2 and fig. 1.)

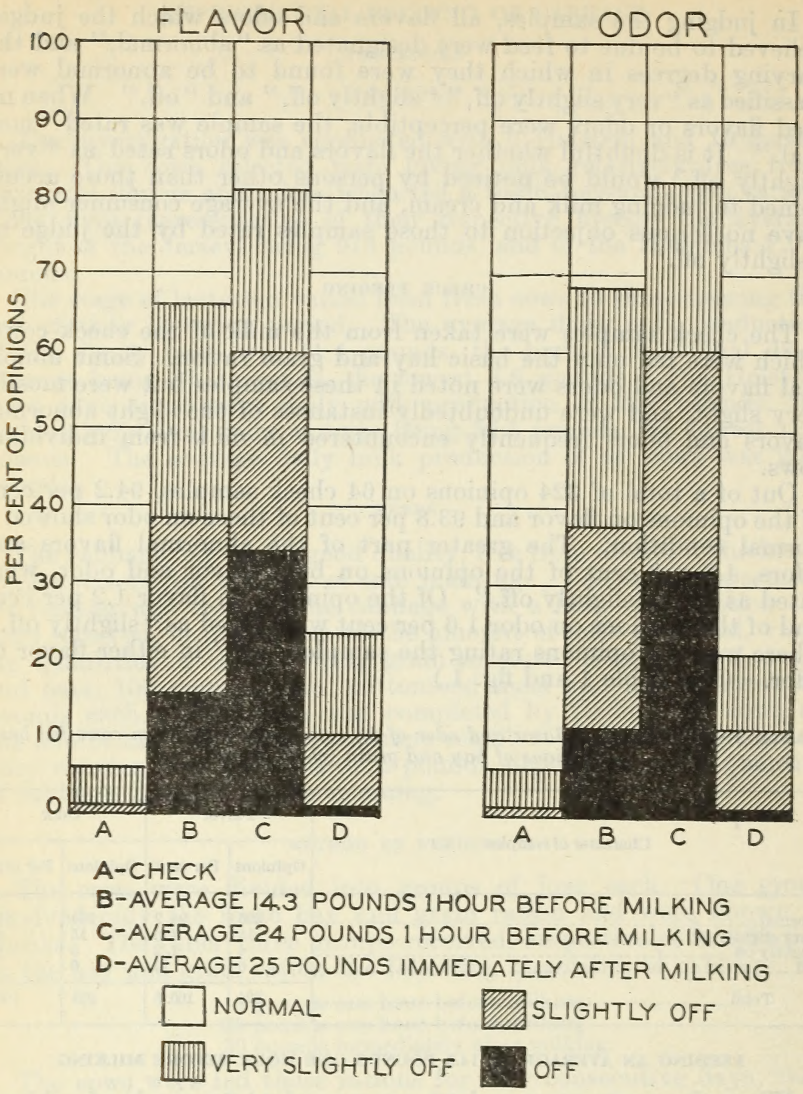

FIG. 1.—Effect of feeding cabbage on the flavor and odor of milk

TABLE 2.—*Opinions on flavor and odor of 52 samples of milk from cows fed 15 pounds (average consumed 14.3 pounds) of cabbage one hour before milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	92	34.0	82	30.3
Very slightly off	76	28.0	86	31.7
Slightly off	62	22.9	71	26.2
Off	41	15.1	32	11.8
Total	271	100.0	271	100.0

FEEDING AN AVERAGE OF 24 POUNDS ONE HOUR BEFORE MILKING

There was a more marked effect on the flavor and odor of the milk when the amount of cabbage consumed one hour before milking was increased from an average of 14.3 pounds (out of 15 pounds fed) to an average of 24 pounds (out of 30 pounds fed). In a total of 358 opinions on 86 samples of milk produced by cows consuming an average of 24 pounds, only 19.6 per cent rated the milk normal in flavor and 16.8 per cent normal in odor.

The percentage of opinions rating the milk very slightly off also decreased somewhat as compared with the milk from cows consuming an average of 14.3 pounds, 21.2 per cent rating the milk very slightly off flavor and 22.6 per cent giving a similar rating to the odor.

The opinions rating the milk as slightly off and off in flavor were increased from 22.9 to 25.7 per cent, and from 15.1 to 33.5 per cent; and those rating the milk as slightly off and off on odor increased from 26.2 to 28.5 per cent, and from 11.8 to 32.1 per cent, respectively. (See Table 3 and fig. 1.)

TABLE 3.—*Opinions on flavor and odor of 86 samples of milk from cows fed 30 pounds (average consumed 24 pounds) of cabbage one hour before milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	70	19.6	60	16.8
Very slightly off	76	21.2	81	22.6
Slightly off	92	25.7	102	28.5
Off	120	33.5	115	32.1
Total	358	100.0	358	100.0

FEEDING AN AVERAGE OF 25 POUNDS IMMEDIATELY AFTER MILKING

There was but slight detrimental effect on the flavor and odor of milk when the cows consumed an average of 25 pounds of cabbage (out of 30 pounds fed) immediately after milking. A total of 176 opinions on 33 samples of milk produced by cows consuming this amount after milking showed that 76.2 per cent of the opinions rated the samples, taken at the next milking, as normal in flavor and 79 per cent as normal in odor.

Among the opinions designating abnormal flavors and odors, 13.6 per cent of the total number rated the samples as very slightly off on flavor, and 9.65 per cent rated them as very slightly off on odor; 8.5 per cent and 1.7 per cent of the opinions rated the flavor slightly off and off, respectively; and 9.65 and 1.7 per cent gave the same ratings to the odor. (See Table 4 and fig. 1.)

TABLE 4.—*Opinions on flavor and odor of 33 samples of milk from cows fed 30 pounds (average consumed 25 pounds) immediately after milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	134	76.2	139	79.00
Very slightly off	24	13.6	17	9.65
Slightly off	15	8.5	17	9.65
Off	3	1.7	3	1.70
Total	176	100.0	176	100.00

EFFECT OF IMMEDIATE AERATION OF THE MILK

In order to determine the effect of aeration on the flavor and odor of milk produced by cows fed cabbage one hour before milking, the milk while still warm was run over a surface cooler, and samples were again taken.

In 167 opinions obtained on 47 samples of milk produced by cows fed 30 pounds (average consumed 24.5 pounds) of cabbage one hour before milking, the percentage of opinions rating the milk normal in flavor was increased by aeration from 15 to 34.7 per cent, and the percentage of opinions rating the milk normal in odor was increased from 12.6 to 26.3 per cent by aeration. Likewise, the percentage of opinions rating the milk very slightly off in flavor was increased from 18 to 18.6 per cent, and of those rating the milk very slightly off in odor from 18 to 29.3 per cent. Before aeration 35.3 per cent of the opinions rated the milk off in flavor; these were reduced to 21 per cent by aeration. The percentage of opinions rating the flavor slightly off was reduced from 31.7 to 25.7 per cent.

Aeration had a similar effect on the odor of the milk. Before aeration 36.5 per cent of the opinions rated the milk off in odor, which was reduced to 24 per cent by aeration; and 32.9 per cent rated it slightly off, which was reduced to 20.4 per cent by aeration. (See Table 5 and fig. 2.)

TABLE 5.—*Opinions on flavor and odor of 47 samples of milk before and after aeration, from cows fed 30 pounds (average consumed 24.5 pounds) of cabbage one hour before milking*

Character of samples	Flavor				Odor			
	Nonaerated		Aerated		Nonaerated		Aerated	
	Opinions	Per cent	Opinions	Per cent	Opinions	Per cent	Opinions	Per cent
Normal	25	15.0	58	34.7	21	12.6	44	26.3
Very slightly off	30	18.0	31	18.6	30	18.0	49	29.3
Slightly off	53	31.7	43	25.7	55	32.9	34	20.4
Off	59	35.3	35	21.0	61	36.5	40	24.0
Total	167	100.0	167	100.0	167	100.0	167	100.0

The effect of aeration was similar to that obtained in previous experiments with silage, green alfalfa, and turnips.

EFFECT ON FLAVOR AND ODOR OF CREAM

A portion of the milk produced by the cows consuming an average of 24.5 pounds of cabbage one hour before milking was set aside for 24 hours, after which samples of cream were skimmed off and judged for flavor and odor. Out of 167 opinions on 47 samples of cream skimmed from the milk, 13.8 per cent rated the cream normal in flavor and 12 per cent rated it normal in odor. This result is very little different from that on the milk from which the cream was skimmed, as 15 per cent of the opinions rated the milk normal in flavor and 12.6 per cent rated it normal in odor.

The percentage of opinions rating the cream either slightly off or very slightly off in flavor was nearly the same as for milk. However,

somewhat lower percentages of slightly off and very slightly off odors was found in the cream. With regard to milk, 18 and 31.7 per cent of the opinions rated the flavor very slightly off and slightly off, respectively, and 17.4 and 31.7 per cent gave similar ratings to the cream. On milk, 18 per cent and 32.9 per cent rated the odor very slightly off and slightly off, respectively; 13.2 and 29.9 per cent gave similar ratings to the cream.

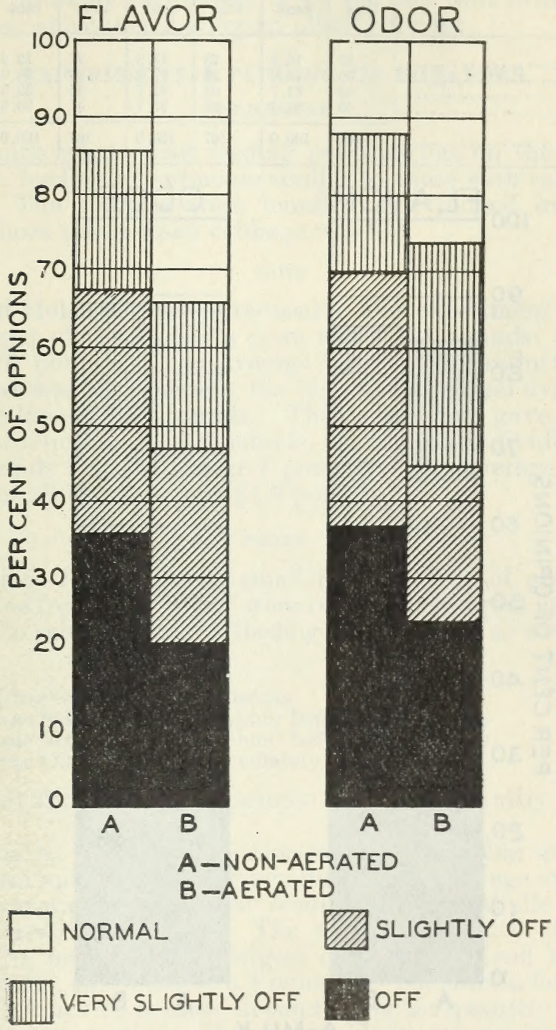

FIG. 2.—Effect of immediate aeration on the flavor and odor of milk from cows fed cabbage

The opinions rating the cream off in flavor and odor showed a higher percentage than those giving a similar rating to the milk, 37.1 and 44.9 per cent rating the cream off in flavor and odor, respectively, while only 35.3 and 36.5 per cent gave similar ratings to the milk. It therefore appears that when abnormal flavors and odors are present in milk these flavors and odors are more pronounced in the cream from such milk. (See Table 6 and fig. 3.)

TABLE 6.—*Opinions on flavor and odor of 47 samples of milk and cream from cows fed 30 pounds (average consumed 24.5 pounds) of cabbage one hour before milking*

Character of samples	Flavor				Odor			
	Milk		Cream		Milk		Cream	
	Opinions	Per cent	Opinions	Per cent	Opinions	Per cent	Opinions	Per cent
Normal	25	15.0	23	13.8	21	12.6	20	12.0
Very slightly off	30	18.0	29	17.4	30	18.0	22	13.2
Slightly off	53	31.7	53	31.7	55	32.9	50	29.9
Off	59	35.3	62	37.1	61	36.5	75	44.9
Total	167	100.0	167	100.0	167	100.0	167	100.0

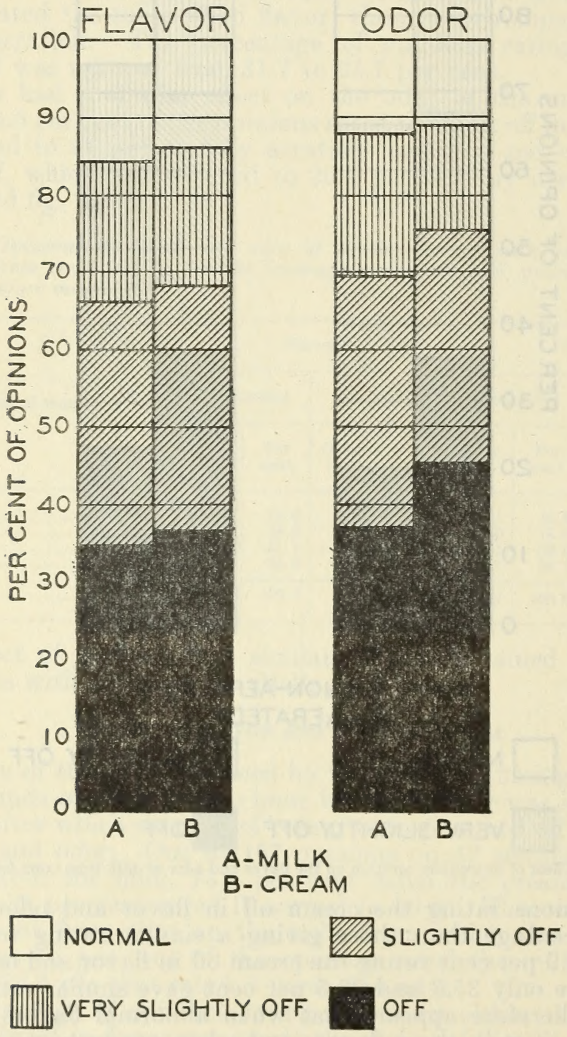

FIG. 3.—Relative effect of cabbage feeding on the flavor and odor of milk and cream

The effect of cabbage on the flavor and odor of cream, as compared with milk, was less pronounced than in a previous experiment with turnips. In both cases, however, the abnormal flavors and odors were more pronounced in the cream than in the milk. When cabbage was fed the difference amounted to only 1.8 and 8.4 per cent in flavor and odor, respectively, compared with 18.5 and 22.2 per cent more off flavors and odors, respectively, in the cream when turnips were fed. This is probably accounted for by the fact that turnips contain an oil or other substance having an affinity for fat.

EXPERIMENTAL FEEDING OF POTATOES

PROCEDURE

To determine what effect feeding potatoes has on the flavor and odor of milk, feeding experiments similar to those with cabbage were conducted. The samples were handled and judged in the same manner as those taken when cabbage was fed.

COWS

Jersey and Holstein cows were used in this experiment also. The average weight of the Holstein cows was 1,154 pounds; the Jerseys averaged 876 pounds. The average daily milk production of the Holstein cows was 26.2 pounds, the highest individual average being 49.9 and the lowest 12.2 pounds. The Jersey cows gave an average daily milk production of 15.8 pounds, the highest individual average being 41 pounds and the lowest 7 pounds. The average daily milk production of all the cows was 21.9 pounds.

FEEDS

The potatoes fed, although small in size, were of good quality, clean, and free from rot. They were run through a root cutter before feeding. The same method of feeding was followed as with cabbage, namely:

One group (checks) was fed no potatoes.
One group was fed 15 pounds one hour before milking.
One group was fed 30 pounds one hour before milking.
One group was fed 30 pounds immediately after milking.

The cows at times failed to consume the entire quantity of potatoes fed.

In addition to potatoes, the cows were fed varying quantities of the same grain mixture as was given during the cabbage experiments, and the ration was completed by feeding as much alfalfa hay as the cows would readily consume. The average quantity of grain fed daily was 11.5 pounds. The largest quantity received by any cow was 23.5 pounds, the smallest 5.5 pounds. The alfalfa hay fed daily varied from 5.7 to 19.8 pounds, depending on the quantity of potatoes the cows were consuming. The average daily consumption was 10.8 pounds.

CHECK FEEDING

Of the check samples taken from the milk produced by cows receiving only the basic hay-and-grain ration, there were but very few in which slightly abnormal flavors or odors were perceptible. A total of 224 opinions on 59 samples showed 96 per cent rating the milk

normal in flavor and 96.9 per cent normal in odor. The greater part of the abnormal flavors and odors, 3.6 per cent and 2.2 per cent of the total opinions on the flavor and odor, respectively, were rated as very slightly off. On flavor, 0.4 per cent of the opinions, and on odor, 0.9 per cent rated the samples slightly off, and none rated a sample off in either flavor or odor. (See Table 7 and fig. 4.)

TABLE 7.—*Opinions on flavor and odor of 59 samples of milk from cows fed basic ration of hay and grain (check cows)*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	215	96.0	217	96.9
Very slightly off	8	3.6	5	2.2
Slightly off	1	.4	2	.9
Off	0	0	0	0
Total	224	100.0	224	100.0

FEEDING AN AVERAGE OF 14.8 POUNDS ONE HOUR BEFORE MILKING

When the cows consumed an average of 14.8 pounds of potatoes (out of 15 pounds fed) one hour before milking, there was but a slight effect on either flavor or odor of the milk produced. A total of 162 opinions on 42 samples of milk produced by cows consuming this quantity of potatoes showed 87.7 per cent of the opinions rating the milk normal in both flavor and odor. In the case of abnormal flavors 8.6 per cent of the opinions rated the milk very slightly off and 3.7 per cent slightly off. Likewise, in odor 7.4 per cent of the opinions rated the milk very slightly off and 4.9 per cent slightly off. None of the opinions rated the milk off in either flavor or odor. (See Table 8 and fig. 4.)

TABLE 8.—*Opinions on flavor and odor of 42 samples of milk from cows fed 15 pounds (average consumed 14.8 pounds) of potatoes one hour before milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	142	87.7	142	87.7
Very slightly off	14	8.6	12	7.4
Slightly off	6	3.7	8	4.9
Off	0	0	0	0
Total	162	100.0	162	100.0

FEEDING AN AVERAGE OF 29.3 POUNDS ONE HOUR BEFORE MILKING

When the quantity of potatoes consumed one hour before milking was increased from an average of 14.8 pounds (out of 15 pounds fed) to an average of 29.3 pounds (30 pounds fed), there was practically no change in the effect on the flavor and odor of the milk. A total of 178 opinions on 47 samples of milk produced by cows consuming the greater quantity of potatoes showed 88.7 per cent of the opinions rating the milk normal in flavor and 88.2 per cent normal in odor. In the case of abnormal flavors 7.9 per cent rated the milk very slightly off and 3.4 per cent slightly off. Likewise, 7.3 per cent of the opinions

rated the milk very slightly off and 4.5 per cent slightly off in odor. None of the opinions rated the milk off in either flavor or odor. (See Table 9 and fig. 4.)

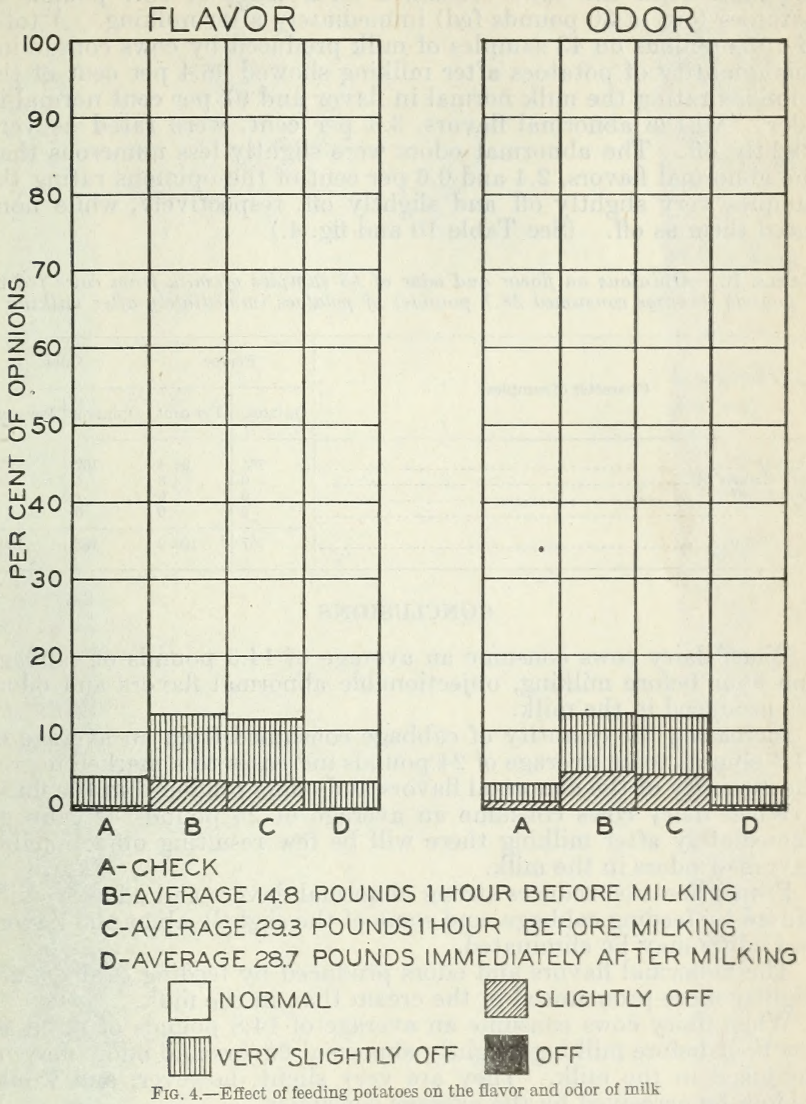

FIG. 4.—Effect of feeding potatoes on the flavor and odor of milk

TABLE 9.—*Opinions on flavor and odor of 47 samples of milk from cows fed 30 pounds (average consumed 29.3 pounds) of potatoes one hour before milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	158	88.7	157	88.2
Very slightly off	14	7.9	13	7.3
Slightly off	6	3.4	8	4.5
Off	0	0	0	0
Total	178	100.0	178	100.0

FEEDING AN AVERAGE OF 28.7 POUNDS IMMEDIATELY AFTER MILKING

There was practically no effect on either the flavor or the odor of the milk when the cows consumed an average of 28.7 pounds of potatoes (out of 30 pounds fed) immediately after milking. A total of 167 opinions on 43 samples of milk produced by cows consuming this quantity of potatoes after milking showed 96.4 per cent of the opinions rating the milk normal in flavor and 97 per cent normal in odor. All the abnormal flavors, 3.6 per cent, were rated as very slightly off. The abnormal odors were slightly less numerous than the abnormal flavors, 2.4 and 0.6 per cent of the opinions rating the samples very slightly off and slightly off, respectively, while none rated them as off. (See Table 10 and fig. 4.)

TABLE 10.—*Opinions on flavor and odor of 43 samples of milk from cows fed 30 pounds (average consumed 28.7 pounds) of potatoes immediately after milking*

Character of samples	Flavor		Odor	
	Opinions	Per cent	Opinions	Per cent
Normal	161	96.4	162	97.0
Very slightly off	6	3.6	4	2.4
Slightly off	0	0	1	.6
Off	0	0	0	0
Total	167	100.0	167	100.0

CONCLUSIONS

When dairy cows consume an average of 14.3 pounds of cabbage one hour before milking, objectionable abnormal flavors and odors are produced in the milk.

Increasing the quantity of cabbage consumed from an average of 14.3 pounds to an average of 24 pounds increases to a marked degree the intensity of the abnormal flavors and odors produced in the milk.

When dairy cows consume an average of 25 pounds of cabbage immediately after milking there will be few resulting objectionable flavors or odors in the milk.

Proper aeration reduces strong abnormal flavors and odors in milk caused by feeding cabbage, and some of the slightly abnormal flavors and odors may be eliminated.

The abnormal flavors and odors produced by feeding cabbage are slightly more pronounced in the cream than in the milk.

When dairy cows consume an average of 14.8 pounds of potatoes one hour before milking, slightly abnormal flavors and odors may be produced in the milk. They are very slight, however, and would seldom be perceived by the average consumer.

Increasing the quantity of potatoes consumed one hour before milking from an average of 14.8 pounds to an average of 29.3 pounds does not increase the abnormal flavors and odors produced in the milk.

When dairy cows consume an average of 28.7 pounds of potatoes immediately after milking, no effect is produced on the flavor or odor of the milk.

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